2006 RESEARCH PERMITS

Charles Schelz / SEUG Ecologist

ARCHES NATIONAL PARK

2006 Research Permits

1) Sucec Permit Denied

2) Permit #: ARCH-2006-SCI-0002

Study Title:

PILOT STUDIES TO INFORM RIPARIAN MONITORING PROTOCOLS – REFINEMENT OF SITE SELECTION METHODS AND FIELD TRIALS OF PROPOSED MONITORING METHODS

Primary investigator contact information:

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Project Summary:
We propose a research program aimed at testing methods described in the current draft protocols for monitoring riparian resources in Southern and Northern Colorado Plateau Network Parks. The monitoring of riparian resources has been identified by both networks as a high-priority because these ecosystems contribute to high local biodiversity and are sensitive to a wide range of on-site and off-site human activities. By conducting field trials, we intend to refine two important components of the riparian monitoring protocols: (1) the site selection process based on the draft stream classification framework; and, (2) the in-field sampling procedures. Pilot studies will allow us to test the application of the classification framework, to conduct methods comparisons trials, to evaluate inter-observer error trials and to determine the number of stream transects within a reach that will be required to adequately characterize variance for selected metrics. Following the pilot studies, we will report the results in the 2006 field trial report and refine the draft riparian protocols; ultimately contributing to rigorous, repeatable and cost effective riparian monitoring protocols for the Southern and Northern Colorado Plateau Networks

Collections:
No material or specimens will be collected for this project.

3) Permit #: ARCH-2006-SCI-0003

Study Title:
THE MOAB SITE ENVIRONMENTAL AIR MONITORING PROGRAM - CONDUCTED BY THE U.S. DEPARTMENT OF ENERGY'S OFFICE OF ENVIRONMENTAL MANAGEMENT LOCATED IN GRAND JUNCTION, COLORADO.

Primary investigator contact information:

Name: Mr. Joel Berwick, U.S. Department of Energy (DOE)
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Project Summary:
DOE's environmental air monitoring program will monitor local and background air quality for various radio-particulates (U-nat, Th-230, and Ra-226), radon-222, and opacity (i.e., fugitive dust emissions). This project was initiated following concerns the Atlas tailings pile might be contributing to declining air quality.

Collections:
Only air samples will be collected at a station set up near the Arches visitor center. No other sampling allowed.

2004 Findings and Status:
Monitoring data collected during 2004 indicate that concentrations of airborne radioparticulates (i.e., Po-210, Ra-226, Th-230, and natural [total] Uranium), atmospheric radon-222, and direct gamma radiation levels observed at the Arches National Park monitoring location are indistinguishable from background (naturally occurring) concentrations and levels. None of the 2004 data collected at this location exceeded any regulatory limit, threshold, or guideline that is applicable to this study. The uranium mill tailings stockpiled at the former Atlas mill site (located approximately 0.75 miles south of the Arches National Park entrance) do not appear to have any significant impact upon air quality and public radiation dose/exposure levels, as measured at the entrance to Arches National Park. DOE is required to conduct environmental monitoring and surveillance at sites where DOE activities have the potential to release contaminants to either the public and/or the environment. DOE will continue to monitor air quality and public exposure limits at this location to document negative exposure and public impacts, and to better understand variations in seasonal air quality conditions.

2005 Findings and Status:
Monitoring data collected during 2005 indicate that concentrations of airborne radioparticulates (i.e., PO-210, Ra-226, Th-230, and natural [total] Uranium), atmospheric radon-222, and direct gamma radiation levels observed at the Arches National Park monitoring location are indistinguishable from naturally occurring concentrations and levels. None of the 2005 data collected at this location exceeded any regulatory limits, thresholds, or guidelines that are applicable to this study. According the measurements taken during this reporting period at the monitoring station near the park entrance, the uranium mill tailing stockpile at Moab UMTRA Project site (located approximately 1/2 mile south of the Arches National Park entrance) does not appear to have any significant impact on the air quality or public radiation dose and exposure levels. DOE is required to conduct environmental monitoring at sites where its activities have the potential to release contaminants to the public and/or to the environment. DOE will continue to monitor the air quality and public exposure limits at this location for the duration of the Moab UMTRA Project to document any exposure impacts and to better understand variations in seasonal air quality conditions.

4) Permit #: ARCH-2006-SCI-0004

Study Title:

CARBON AND NITROGEN CYCLES IN ARID LANDS: THE ROLE OF BIOLOGICAL SOIL CRUSTS AS INFLUENCED BY SOIL SURFACE DISTURBANCE, CLIMATE CHANGE AND ANNUAL GRASS INVASION

Primary investigator contact information:

Name: Dr Jayne Belnap, USGS Canyonlands Field Station
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Phone: 435-719-2333 **Email:** jayne_belnap@usgs.gov

Project Summary:

Models indicate the presence of a large carbon (C) sink at temperate latitudes in the northern hemisphere. Over thirty percent of lands both globally and in the United States consist of semi-arid or arid landscapes. Very little is known about carbon dynamics in these regions. Biological soil crusts, composed primarily of cyanobacteria, algae, lichens and mosses, can completely cover plant interspaces in undisturbed areas, and constitute 70 percent or more of the living ground cover. These soil crusts can be the dominant source of nitrogen (N) for vascular plants. They fix C at a high rate and are critical for soil stability and aggregate formation, which is important in C storage. They also absorb significant amounts of CH4. In areas where precipitation is low and soils have low fertility, native plants often rely on intact biological soil crusts to provide increased water and nutrient flow to the broadly scattered vegetation. Thus, there are many ways in which biological soil crusts influence biogeochemical cycles and the structure and productivity of the vascular plant community.
Soil surface disturbance, invasive plants, and climate change have the potential to dramatically alter the structure and function of biological soil crusts. The current combination of recreational use and livestock grazing is resulting in unprecedented levels of surface disturbance on many arid lands. In regions that did not have substantial amounts of surface disturbance in the Holocene, biological soil crusts disappear readily when trampled by animals or vehicles. Exotic annual grasses are invading many of these areas. Trampling and invasion results in reduced cover and changes in the species composition of biological soil crusts. This, in turn, leads to changes in processes such as decomposition, N and C fluxes, soil moisture, and nutrient availability to vascular plants. Decreases of only 1 percent of soil organic carbon in the top 10 cm of rangeland soils is equivalent to the total C emissions from all croplands nation-wide.

Changes in climate regimes, such as a shift in the summer monsoonal boundaries in the western United States, are expected to influence the composition and physiological functioning of biological soil crusts. Various crust components have different photosynthetic and respiration responses to temperature and moisture. In addition, different crusts have different methane fluxes. Therefore, changes in the timing or amount of temperature and precipitation is expected to alter soil C and N fluxes through changes in physiological response or crustal composition. This, in turn, can significantly impact vascular plant productivity.

This project will establish how alterations in species composition by surface disturbance, invasive grasses, and/or climate change may affect N and C inputs and fluxes, in different soils under different climatic regimes. Because current and expected changes in land use and climate will occur over millions of acres in western rangelands, impacts to soil crusts have the potential for dramatically affecting C cycles, N cycles, and vascular plant productivity over much of the western United States. In addition, semi-arid and arid ecosystems represent over one-third of the Earth's terrestrial surface, and most are covered by biological soil crusts. As human impacts are escalating both regionally and globally in these drier regions, the research questions posed in this proposal have significant implications for global C budgets as well.

Collections:

Soils from the top 10 cm of the soil surface will be collected using a small (<1" diameter) soil auger. At each site, approximately 20 auger samples will be haphazardly collected from an area approximately 20x20 m. Holes are small enough that they self-fill shortly after the disturbance. These samples will be taken once each year.

All samples will be destroyed in analysis.

2005 Findings and Status:

STRUCTURE AND FUNCTION OF SOIL BACTERIAL AND FAUNAL COMMUNITIES AROUND A GRASS AND SHRUB AS INFLUENCED BY BIOLOGICAL SOIL CRUSTS . Vascular plants and soil crusts provide resources directly to soil bacteria and faunal grazers, and indirectly to other soil fauna that feed on them. Plants and soil

crusts may also shape the structure and function of soil communities by controlling inputs of carbon, nitrogen, water and light into the soil. Because soil resource availability is expected to decline with decreased plant and crust cover, and differ by plant and crust type, we examined two plant and crust types to quantify underlying soil chemistry and bacterial and faunal communities. In two separate locations, containing both early successional (Microcoleus dominant) and later successional (Nostoc/Scytonema/Collema) soil crusts, we sampled three microsites (stem, dripline, and interspace) around a dominant shrub (Coleogyne ramosissima) and grass (Stipa hymenoides). Soil chemistry analyses revealed N availability typically was greater at the plant stem, while P availability was greater in interspaces around Coleogyne. Microsites closer to the plant had greater abundance of rhizosphere-dependent bacteria and nematodes, regardless of crust type. Soil protists, however, rarely differed by microsite in either crust type, indicating that soil crusts may more strongly influence their distribution than vascular plants. Abundance of soil biota also differed by plant species, with Coleogyne supporting more bacteria and fauna than Stipa. Overall, these results support the hypothesis that plants and biological soil crusts affect the structure and function of soil bacterial and faunal communities. Global change induced shifts in plant community composition or losses of biological soil crusts in the southwestern US will likely result in reduced soil nutrient cycling via declines in plants, biological soil crusts, and their dependent organisms.

5) Permit #: ARCH-2006-SCI-0005

Study Title:

IMPACT OF INTRODUCED GRASSES ON GRASSHOPPER COMMUNITIES IN COLORADO PLATEAU GRASSLANDS: IMPLICATIONS FOR POPULATION VIABILITY OF NATIVE PERENNIAL GRASSES

Primary investigator contact information:

Name: Dr. Tim Graham, USGS
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Phone: 435 719-2339 **Email:** tim_graham@usgs.gov

Project Summary:

The change from native to non-native grasses affects quality, quantity and timing of available food for grasshoppers and other herbivores. Grasshopper community composition changes, and pressure on remaining native perennial grasses increases. Insectivores also respond negatively to dominance by non-native grasses, primarily because of a simplification of plant architecture. Predation on grasshoppers and other herbivores thus decreases, resulting in additional consumption of remaining native species. It has been suggested that increased herbivory reduces competitive ability of native grasses enough that non-native species are able to maintain dominance even after the disturbances that allowed establishment have ceased.

The proposed study will document differences in grasshopper community structure in native and cheatgrass dominated grasslands of the Colorado Plateau, and correlate these differences with characteristics of the grassland vegetation communities such as amount of bare ground, grass height, cover of perennial and annual grasses, etc. Implications for interactions between cheatgrass and native perennial grasses will be explored as well. In particular, the effect of maturing cheatgrass on grasshopper survival and fecundity, and thus population size, will be tested, and experiments on competitive abilities of cheatgrass vs. selected native grasses with and without grasshopper herbivory will be conducted. The study could be expanded to the Great Basin and Columbia River Basin, which are also being overrun by cheatgrass and other introduced plants, to see if herbivory plays a role in continued dominance by these exotic species in other arid and semi-arid grasslands.

Collections:

The collection of voucher specimens of grasshoppers only is allowed. Specimens will be stored at the Northern Arizona University-Colorado Plateau Museum of Arthropod Biodiversity.

2005 Findings and Status:
No activity was conducted in Arches NP in 2005 related to this project.

6) Permit #: ARCH-2006-SCI-0006

Study Title:
VEGETATION DATA COLLECTION IN SUPPORT OF THE U.S. GEOLOGICAL SURVEY NATIONAL PARK SERVICE VEGETATION CLASSIFICATION AND MAPPING PROGRAM AT ARCHES NATIONAL PARK

Primary investigator contact information:

Name: Mr. James Von Loh, Engineering-Environmental Management, Inc.
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Project Summary:
The National Park Service (NPS) and U.S. Geological Survey (USGS) are cooperating to produce detailed vegetation classifications and digital databases, including vegetation maps, as part of the National Biological Information Infrastructure Program (NBII). Approximately 250 national parks and monuments will benefit from this cooperative effort upon successful program completion. The National Park Vegetation Classification and Mapping Program is a strong component of the NPS Inventory and Monitoring Program, established in 1991, and is based on a repeatable set of standards and flexible protocols.Sampling will be conducted in accordance with the Vegetation Classification and Mapping Work Plan developed for Arches National Park in February 2003, which has been reviewed by USGS-NPS Vegetation Classification and Mapping Program leaders, Northern Colorado Plateau Network (NCPN), and/or Arches ecologists. This work plan will serve as the basis for all such efforts at the park, including sampling methodology, and should be considered as the study proposal. Copies of the work plan, both electronic and hard-copies, are available through the NCPN Inventory and Monitoring Program, or from the park ecologist.

The field work to be performed this spring is related to accuracy assessment of the vegetation map. Following completion of the vegetation map, a random sample of points will be determined by Gery Wakefield and Aneth Wight that will be used to test the accuracy of mapped data. At this time I do not know the exact number of points or their locations, but would expect them to be in the range of 800-1,000. Field biologists (Vegetation mapping crews from NCPN led by Liz Ballenger) will download the AA point UTM coordinates into GPS receivers and navigate to the point. They will complete an accuracy assessment form that provides location, environmental, and vegetation cover information and will also key the vegetation of the area around the point (40 m radius circle) to a plant association using an illustrated field key. Two or more photographs will be taken to adequately document the site. These data will be entered into a database and analyzed to produce a contingency table illustrating the accuracy of each plant association tested and will also provide the overall map accuracy. The national map accuracy standard is 80% accuracy for each map unit and 80% accuracy for the entire map.

Collections:
Collection of parts of plants for identification purposes only allowed. These must be destroyed in analysis. Plant species that are very uncommon or are legally protected under the Endangered Species Act will not be collected but will have digital photos taken for documentation. No curation of plants is allowed.

2005 Findings and Status:

While no field data collection was performed in ARCH in 2005, several other vegetation classification and mapping tasks were conducted. An illustrated field key of the 62 plant associations for ARCH was produced with photos and a dichotomous key. Photo interpretation created a vegetation map with a legend key that was digitized. Also, local descriptions of the 62 plant associations identified for ARCH were produced describing the environmental conditions and species present for the associations within the park.

7) Permit #: ARCH-2006-SCI-0007

Study Title:
HERBARIUM AND FIELD STUDIES OF VASCULAR PLANT FLORA OF ARCHES NP FOR NATIONAL PARK SERVICE INVENTORY AND MONITORING PROGRAM

Primary investigator contact information:

Name: Walter Fertig
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Project Summary:
The purpose of this study is to document the vascular plant flora of Arches National Park (ARCH) and develop a plant distribution database using the National Park Service's NPSpecies system.

2005 Findings and Status:
As a first step in developing an updated species list and distribution database for the park, I examined all specimens in the Arches NP herbarium to correct misidentifications, update species nomenclature (following Welsh et al. 2003, "A Utah Flora, third edition"), and add variety or subspecies names if needed. Of the 623 specimens currently deposited in the collection, 32 were misidentified (5.1%), 28 had their names updated (4.5%), 122 had variety names added (19.6%), and 441 were confirmed as correctly identified (70.8%). Another 259 specimens reported in the park's museum database (ANCS+) are presently on loan and could not be verified. The Arches herbarium currently contains 365 vascular plant taxa collected within the park (plus an additional 14 species from outside park boundaries). At least 122 additional plant species have been reported for Arches NP by Schelz and Moran (2005 SE Utah Group Plant list) and Harrison et al. (1964 "Plants of Arches National Monument, BYU Biological Series 5(1):1-23) but are not represented by collections in the Arches herbarium. Based on the Atlas of the Utah Flora (Albee et al. 1988), 229 additional species are reported from comparable habitats in the vicinity of Arches NP, but have not yet been documented within the park. These results suggest that the Arches NP herbarium is missing a significant number of plant taxa known or likely to occur in the park. In particular, fall-flowering and wetland species appear to be under-represented. Targeted inventory work to fill gaps in the Arches NP vascular plant collection is recommended so that park manager's will have an improved understanding of the composition and status of the flora of the park and a more complete reference collection for researchers and staff interested in plant identification.

8) Permit #: ARCH-2006-SCI-0008

Study Title:
A STUDY TO DETERMINE THE AGE AND SOURCE OF RECHARGE FOR THE WATERS OF THE MOAB MEMBER AND NAVAJO SANDSTONE AQUIFERS IN THE COURTHOUSE WASH AREA, GRAND COUNTY, UTAH

Primary investigator contact information:

Name: James Harte
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Project Summary:
This project consists of the sampling and analysis of water from four ground water wells and four springs near the west boundary of Arches National Park, located about ten miles north of Moab, Utah. The wells and springs are located along an approximately ten-mile section of the geologic structure known as the Courthouse Syncline. Two of the ground water wells produce water from the Navajo Sandstone aquifer and two ground water wells produce water from the Moab Member aquifer. The source of water for the springs is the Moab Member aquifer (Hurlow and Bishop, 2003). The Utah Geological Survey (UGS), 1594 West North Temple, Suite 3110, P.O. Box 146100, Salt Lake City, Utah 84114-6100 will be responsible for the collection and analysis of the water samples under the direction of Jim Harte, National Park Service, Water Resources Division. The UGS contact will be Mr. Mike Lowe, (801) 537-3389.

OBJECTIVE:
Determine the relative age and source of recharge for waters of the Moab Member and Navajo Sandstone aquifers. "Fingerprint" waters from Moab Member and Navajo Sandstone aquifers. Determine if a connection exists between the Moab Member and Navajo Sandstone aquifers near the west boundary of Arches National Park.

DESCRIPTION OF SITE LOCATIONS AND WORK TO BE PERFORMED
The National Park Service desires to test ground water and spring water in the Navajo Sandstone and Moab Member aquifers from sources adjacent to Arches National Park to determine its chemical characteristics, age, and source of recharge.

SAMPLE COLLECTION:
Samples will be collected by UGS personnel using applicable standard USGS sampling protocol. Water samples from each well and spring site will be analyzed at a certified laboratory using established EPA analysis protocol.

Water samples collected from each well and spring will be analyzed for the following constituents: General Chemistry (State of Utah Type 3), Ammonia, Dissolved Nitrate and Nitrite, Dissolved Total Phosphate, Total Phosphate, Carbon 14, Tritium, Oxygen 18 and Deuterium.

9) Permit #: ARCH-2006-SCI-0009

Study Title:
SOIL SURVEY OF ARCHES NATIONAL PARK, UTAH

Primary investigator contact information:

Name: Mr Victor Parslow, USDA Natural Resources Conservation Service
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Phone: 435.896.6441 ext. 134 **Email:** Vic.Parslow@ut.usda.gov

Project Summary:
To provide an updated soil and ecological site inventory for Arches National Park (ARCH), that meets National Cooperative Soil Survey (NCSS) standards and park management and planning needs.

The existing soil survey was conducted in the 1970s's and the early 1980's as part of the Henry Mountains, Utah soil survey and the Arches Soil Survey. These inventories was primarily designed as a tool for use in managing grazing lands and has been found to be too general to be useful in managing the park. Information is insufficient to model salt movement, mitigate visitor impacts, identify and protect habitat of Threatened and Endangered species, and other park responsibilities.

In 2003, reprensentatives of the National Park Service approached the Natural Resources Conservation Service to update the existing soil surveys within Arches and Canyonlands National Parks and Natural Bridges and Hovenweep National Monuments and the Orange Cliffs section of the Glen Canyon Recreation Area. The Plan of Work and contract were approved in 2004. This application is seeking permission to carry out the field work necessary to complete the contract.

Collections:
Soil sampling allowed: 200 to 300 gram soil samples only. Archeologist must be present when digging any holes in ground. Some clipping of vegetation is allowed but must be kept to a minimum. Majority of soil samples will be destroyed in analysis. No collection of plants is allowed. Photos of plants for identification purposes is allowed.

10) Permit #: ARCH-2006-SCI-0010

Study Title:

CO2 GEOLOGICAL STORAGE :
LONG TIME GEOCHEMICAL REACTIVITY OF ARGILLACEOUS CAP-ROCKS MATRICES

Primary investigator contact information:

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Project Summary:
The aim of this PhD study is to investigate the long term behaviour of cap-rocks for CO2 geological storage, where argillaceous minerals are abundant. In this context, we will focus on polycrystalline diagenetic clay-rich rocks, avoiding any consideration on fractures. In particular, we want to determine what could be the role of mineral reactivity and fluid-rock interactions for assessing risks involved in the choice of a geological storage site.

Three approaches are possible to validate a potential geological storage site. The first approach consists in using and studying some field analogues, where CO2 paleo fluids bearing sediments crop out. This approach is limited by the number of good and accessible sites, which makes some compromises more difficult to make and thus introduces unquantitative uncertainties. We can also underline that pressure-temperature-time constrains on natural samples are complex to obtain and in many case, not precise enough to give any information on the time-duration of CO2 accumulation and residence. A second possibility is to undertake numerical simulations of large scale fluid-rock chemical reactions and transport. In this case, models are limited by the knowledge of physical and chemical constants (thermodynamics and kinetics for example) and by their capabilities to fit natural analogues or experiments on natural samples. Lastly, in terms of durability and predictability, using experimental simulations on natural samples is drastically limited to time durations of experimental runs.

We propose to elaborate an experimental protocol, to quantify some constants used in the numerical simulations (based on experimental synthetic materials), and on the other hand, to validate numerical simulations based on a geological time scale from different experimental tests on natural samples. The experimental methodology will be validated by comparing the different approaches on natural CO2 bearing samples from different geological environments (Colorado, Italy, …).
By these combined approaches using numerical modelling, experimental simulations, and natural samples characterisation, the study will attempt to predict reactive behaviour of argillaceous matrices that compose aquifer/reservoir cap-rocks and which are progressively invaded by CO2 gas or dissolved CO2.

The first task is to quantify mineralogical changes as a function of geological times, and later, to calibrate some of the parameters (thermodynamics and kinetics) in order to validate some of the numerical models (textural model for example) of fluid-rock transport aimed at predicting storages behaviours.

This PhD should then make a critical review of the present numerical models possibilities in use at I.F.P., and allow better long term geological phenomena to be estimated. From this study, an experimental protocol to validate an hypothetical storage site will be given to avoid systematic research of natural analogues.

Collections:
Small loose rock samples only are allowed for collection. No chipping from larger rocks allowed. The only rock samples approved for collection are those that are loose on the ground. Limited to a total of 10 samples for the entire project, each sample no larger than 10cm by 10cm by 10cm. All Specimens shall be destroyed in analysis.

11) Permit #: ARCH-2006-SCI-0011

Study Title:

RIPARIAN AND AQUATIC INVERTEBRATE MONITORING PROTOCOL AND DEVELOPMENT (NPS I&M PROGRAM)

Primary investigator contact information:

Name: Dr Anne Brasher, USGS, Water Science Center
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Project Summary:
The objective of the study is to develop a rigorous, well-integrated set of protocols for long-term riparian and macroinvertebrate monitoring across the Colorado Plateau. Another objective is to evaluate the utility of aquatic macroinvertebrates and riparian ecosystems as reliable indicators of aquatic ecosystem conditions in dryland systems characteristic of the Colorado Plateau.

Collections:
In general, macroinvertebrate samples are destroyed during analysis. Upon arrangement with the Park curator, a voucher collection from the sampling effort can be maintained at an established (museum) location following NPS repository standards.

Only the collection of aquatic invertebrates allowed. Most will be destroyed in analysis. Those curated will be stored according to NPS regulations at the Utah State University Bug Lab.

2005 Findings:
No activity was conducted during this report year.

12 Permit #: ARCH-2006-SCI-0012

Study Title:

IMPACTS OF CLIMATIC CHANGE AND LAND USE ON THE SOUTHWESTERN U.S.

Primary investigator contact information:

Name: Dr. Jayne Belnap, USGS, Canyonlands Field Station
Address: 2290 SW Resource Blvd., Moab, UT 84532
Phone: 435-719-2333 **Email:** jayne_belnap@usgs.gov

Project Summary:
The population of the southwestern United States has grown rapidly over the past two decades and is projected to increase greatly over the next several decades. As the population has grown, climatic variations that would have affected relatively few people in the past will impact the lives of millions. Rapid and wide-spread climatic changes, such as those seen thousands and hundreds of years ago in the region and those projected for the future, may profoundly change the character of the region. Arid and semi-arid regions of the southwestern U.S. are among the most sensitive regions to changes in climate and land use, but the potential interactions between climatic change and land use are largely unknown (http://climweb.cr.usgs.gov/info/sw_new/swmap.html).

U.S. Geological Survey and collaborating scientists are seeking to understand how climate and how land use have influenced surficial geologic processes that modify landscapes and ecosystems. Such understanding is then used to model the landscape's response to future changes in climate and land use over time scales of seasons, of a few years, and of a few decades, so that information and interpretations can be applied by federal, state, and local agencies, as well as by Native American governments, for their land-use planning and management of resources.

Project scientists work with ecologists, hydrologists, geographers, cartographers, and archeologists to address questions about:
(1) the causes and timing of changes in alluvial environments (rivers, streams, hillslopes), such as flooding, the cutting and filling of arroyos, and sediment discharge;
(2) the role of eolian dust for soil fertility, invasion of exotic species, hydrology, and surface stability in deserts;
(3) the interaction of physical and biologic processes critical for ecosystem functions;
(4) how climate in the southwest has varied over decades, centuries, and millennia;
(5) how future climatic variations will affect the Southwestern land surface (in terms of erosion, sand-dune activity, dust-storm frequency, flooding, landslides,);
(6) how past climatic changes and environments affected prehistoric cultures.

General Project Goals
1 Understand how past climatic change affected land surface: soil loss, fluvial erosion and alluviation, sand-dune mobilization, ecosystems, under time frames of past decades, centuries, and millennia.
2 Understand today's interplay among climate, land use and surface processes (geologic and ecologic).
3 Understand the impacts of future climate on land surface under the following time frames: seasons; El NiTo/La NiTa cycles; multi-year wet/drought periods; and decades, as atmospheric CO2 increases.

A major goal is to interact with federal, state, and local government agencies as well as non-governmental organizations to provide information useful for management decisions regarding land-surface vulnerability to wind erosion. Another goal is to provide to managers and other parties ongoing remote sensing and meteorological monitoring bearing on the vulnerability of the land to natural and human disturbances.

Specific goals for Canyonlands work
1 Understand geologic origins of soil nutrients and the interactions of soil compounds and plants.
2 Understand geomorphic controls on plant distribution

3 Understand the recent (past several decades, centuries, millennia) geologic/geomorphic evolution of the ecosystem to reveal patterns of surface stability and instability.
4 Recognize areas vulnerable to wind erosion and soil loss.
5 Understand conditions of cheatgrass (and other exotic plants) invasion to predict areas most vulnerable to expansion and to help devise mitigation strategies.

2005 Findings and Status:
Report from USGS Project Effects of climatic variability and land use on American Drylands.

The project conducts research on linkages among geologic substrates and their origins; biogeochemical nutrient cycling; weathering of substrate; soil moisture and water infiltration; weather events and climate; surface dynamics, including erosion; as well as past and current land uses. A large component of research is devoted to understanding how geologic substrates influence plant community distributions, including the distribution of cheatgrass and other invasive plants. Another focus is on the effects of historical grazing on soil nutrients. Substantial progress has been made in both topics as summarized in publications listed below that are available at the project website. Progress has also been made in developing remote sensing techniques to track invasion of Park lands by invasive plants. Another major effort last year resulted in publication of a document that describes conceptual models for dryland ecosystems to inform the vital signs selection process. Much project work is designed to address land-management priorities.

Activities of work done in and near Arches National Park are summarized in the project website http://climchange.cr.usgs.gov/info/sw/index.html

Project members completed several studies that resulted in publications.

Multi-decadal impacts of grazing on soil physical and biogeochemical properties in southeast Utah
J.C. Neff, R.L. Reynolds, J. Belnap, and P. Lamothe, 2005, Multi-decadal impacts of grazing on soil physical and biogeochemical properties in southeast Utah: Ecological Applications, 15(1), 2005, pp. 87-95.

Atmospheric dust in modern soil on aeolian sandstone, Colorado Plateau (USA): Variation with landscape position and contribution to potential plant nutrients
R.L. Reynolds, J.C. Neff, M. Reheis, P. Lamothe, 2006, Atmospheric dust in modern soil on aeolian sandstone, Colorado Plateau (USA): Variation with landscape position and contribution to potential plant nutrients: Geoderma, v. 130, p. 108-123.

Late Quaternary eolian response to paleoclimate, Canyonlands, southeastern Utah
M.C. Reheis, R.L. Reynolds, H. Goldstein, H.M. Roberts, J.C. Yount, Y. Axford, L. Cummings, and N. Shearin, 2005, Late Quaternary eolian and alluvial response to paleoclimate, Canyonlands, southeastern Utah: GSA Bulletin, v.117, no. 7/8, p. 1051-1069.

13) Permit #: ARCH-2006-SCI-0013

Study Title:

DEVELOPMENT OF A RESTORATION RAPID ASSESSMENT TOOL (RRAT) FOR THE NATIONAL PARK SERVICE TO PRIORITIZE SITES FOR WEED CONTROL AND RESTORATION

Primary investigator contact information:

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Project Summary:
The purpose of this study is to develop a protocol with which to rapidly assess disturbed sites within the National Park Service, so the resource managers may easily prioritize sites for restoration. The RRAT uses ecological attribute indicators of soil, hydrology and vegetation to assess the health and condition of a site. We will be field testing the RRAT on actual disturbed sites within the Colorado Plateau and Midwest Parks so that we may detect inefficiencies among indicators. Ideally, this field study will help guide us in making future modifications that will allow for an RRAT that is more usable and helpful to resource staff.

Objectives:
The RRAT project has been in the making since 2003 over a series of "phases". Phase 1 involved the draft of the RRAT and an email survey sent out by former Northern Arizona University (NAU) graduate student Rebecca Harms (Harms, 2003). The survey asked NPS resource managers and staff what weeds threatened their ecosystems most and what protocols they currently used to prioritize sites for restoration. In phase II, NAU graduate student Amy Richey set out to test the validation of three of the six attributes upon which the RRAT indicators are based: hydrology/landform, soils/water quality, and vegetation. The other attributes include animal stressors, site value, and land use history. In her research, Richey found that while the vegetation indicators provided valid assessments of site condition, hydrology/landform and soil/water quality did not. Phase III's objectives seek to take the RRAT to the field once again to test whether NPS resource staff with varying levels of knowledge and experience achieve the same results with RRAT. Also, because RRAT has only been tested in riparian areas, we seek to test whether the RRAT may transcend its utility beyond riparian areas, by taking it to upland and other non-riparian areas. Other objectives for summer 2006 research include testing economy/efficiency of RRAT, and testing each attribute's efficacy (of hydrology/landform and soil/water quality and vegetation) at discriminating between sites.

Hypotheses to be Tested:

1. Do resource managers with different levels of experience, education, and knowledge respond similarly to the RRAT? (sampling error)
2. How do RRAT prioritization scores compare with current resource manager prioritization strategies?
3. How does each attribute alone (vegetation, soil, hydrology) discriminate between sites vs. the RRAT?
4. Does the RRAT help resource managers conceptualize a restoration strategy?
5. Is the RRAT adaptable to non-riparian sites?
6. Does the RRAT detect sites where a little restorative action would lead to a large benefit or where lot's of restorative action would earn few benefits?

Methods:

The field testing will involve visiting National Parks within the Colorado Plateau. Ideally, the RRAT will be conducted on 3-5 field sites per park. NPS resource managers will be asked to choose the sites in advance so that they compose an array of degrees of disturbance. Multiple

resource manager presence at each site will allow us to determine sampling error between RRAT users.

Collections:
The collection of specimens is not allowed.

Logistics:
The park will be notified and park ecologist will accompany the researcher in the field.